CHAPTER 9
ADDITIONAL ENVIRONMENTAL IMPROVEMENT APPROACHES

CHAPTER CONTENTS

This chapter focuses on techniques that may be employed by fabricare operations to prevent pollution, reduce chemical consumption, and minimize waste, with significant emphasis on perchloroethylene (PCE) and hydrocarbon (HC) solvent technologies. Section 9.1 examines the pollution prevention options with the potential to achieve environmental improvements for facilities using PCE and HC solvent technologies. The most common operating and maintenance procedures, control devices, and their effects are presented, including options for recycling. Methods for extracting solvents are addressed, as are methods for treating spent solvents so that they may be reused. In addition, this section discusses the impact of facility conditions and remedial actions on PCE concentrations in co-located residences (i.e., residences located in the same building as a fabricare operation). Section 9.2 suggests practices and improvements that may help cleaners using machine wetcleaning reduce chemical releases and exposure. Section 9.3 provides a summary of the several major clothes cleaning trade and research associations, their contact numbers, and some of their initiatives and publications involving environmental improvement practices.

9.1 PCE AND HC DRYCLEANING FACILITIES

9.1.1 Recommended Operating and Maintenance Procedures

On September 22, 1993, USEPA finalized the National Emission Standard for Hazardous Air Pollutants (NESHAP) for PCE drycleaners (58 FR 49354). This regulation set standards for the reduction of PCE emissions from drycleaning operations. Included in the NESHAP were requirements that owners or operators of drycleaning machines and control devices follow their manufacturers' instructions for the proper operation and maintenance of machines and control devices. Owners or operators are required to keep a copy of any manufacturers' specifications or operating and maintenance recommendations at the drycleaning facility.

USEPA realizes that some drycleaners may no longer have equipment manuals for older drycleaning machines and control devices. However, owners or operators of older machines and control devices should make every reasonable effort to obtain these manuals. These efforts include contacting manufacturers, if the manufacturers are still in business, and contacting local, state, and national trade associations.

In case efforts to obtain manufacturers' manuals are unsuccessful, USEPA's Office of Air Quality Planning and Standards (OAQPS) has developed many of the following recommendations for operating and maintenance practices for owners or operators of PCE drycleaning machines and emission control devices. The Office of Pollution Prevention and Toxics (OPPT) has supplemented the 1994

OAQPS recommendations, primarily based on some more recent information. These recommendations serve only as a last resort when manufacturers' information is not available. They should never supersede available manufacturers' information.

This section includes various practices and improvements that may help drycleaners reduce releases, exposures, and usage of PCE or HC solvents. This section primarily provides recommendations on the operation and maintenance of PCE drycleaning equipment but also contains suggestions for HC drycleaning equipment. In 1992, the International Fabricare Institute (IFI) published an "Industry Focus" (IFI, 1992) documenting general information on the operation and maintenance of petroleum drycleaning equipment. For drycleaners using HC equipment, this IFI publication is likely more informative and relevant than the information provided in this chapter of the Cleaner Technologies Substitutes Assessment (CTSA). It should also be noted that some of the changes identified in this section may not be appropriate when site-specific factors are taken into account. Emphasis is placed on the importance of operating and maintaining the drycleaning equipment according to manufacturers' specifications. Training workers on proper maintenance and operating procedures may serve to further reduce releases, exposures (including their own exposures), and usage of solvents.

Maintenance and Operation of Drycleaning Machine Components

Exhibit 9-1 provides a summary of recommended maintenance practices for drycleaning machine components when manufacturers' information is not available. These recommendations should never supersede available manufacturers' information. The remainder of this section discusses those practices in more detail. Exhibit 8-3, "Summary of PCE NESHAP Compliance Requirements for Drycleaners," identifies the items required by the NESHAP and references other USEPA documents that contain details for complying with NESHAP requirements.

Dry-to-Dry Machine Cylinder

Although dry-to-dry machines wash and dry garments in one cylinder, PCE emissions can come from many sources, which include the cylinder, a leaking door gasket or other gaskets, and the unloading of garments that have not been adequately dried (reclaimed). Drycleaning operators should detect and repair liquid and vapor PCE leaks during a weekly inspection program. If a liquid leak is detected, the operator should replace the seal immediately because significant PCE loss can occur. Vapor leaks can sometimes be detected by running a finger along the entire perimeter of the door seal while the machine is operating or by placing a liquid bubble solution around the door seating and looking for bubbles. An electronic halogen leak detector is capable of locating vapor leaks that other methods might miss.

Vented dry-to-dry machines and dryers with add-on refrigerated condensers or carbon adsorbers have exhaust dampers to control the flow of hot air. Because the exhaust damper can be a major source of PCE losses, operators should check it monthly to ensure that it is functioning properly. Even though the exhaust damper is usually difficult to access, every effort must be made to check and repair it. Operators may check for leaks by placing and sealing a collapsed, inflatable plastic bag over the ductwork used to vent the dry-to-dry machine. Operators should ensure that the bag is placed at a point downstream from the direction of flow past the exhaust damper. If the exhaust vent outlet cannot be used, operators may need to make some minor modifications to the ductwork, such as drilling a small test hole, which can be

Exhibit 9-1. Maintenance Schedule for Drycleaning Equipment

Component	Frequency	Maintenance Procedure
Machine Component		
Dry-to-dry machine cylinder	Weekly	Check door seatings and gaskets for leaks.
	Monthly	Check exhaust damper (vented machines) for leaks.
Transfer washer/extractor cylinder	Weekly	Check door seatings and gaskets for leaks.
Transfer dryer (reclaimer)	Weekly	Check door seatings and gaskets for leaks.
	Monthly	Check exhaust damper for leaks.
Heating and condensing coils	Monthly	Check for lint build-up.
	Annually	Clean coils.
Button trap	Daily	Clean strainer.
	Weekly	Check lid for leaks.
Fans	Annually	Inspect and lubricate.
Lint trap	Daily	Clean lint bag, check lint build-up on temperature probe, and check ductwork for lint build-up.
	Weekly	Dryclean or launder lint bag.
Auxiliary Equipment		
Filters	[a]	Clean and change filters (filters drained and muck stored in sealed containers).
Distillation unit	Bi-weekly	Check seals and gaskets for leaks.
	Monthly	Check steam and condensation coils.
	Semi-annually	Clean steam and condensation coils.
Muck cooker	Monthly	Check steam and condensation coils.
	Semi-annually	Clean steam and condensation coils.
	Annually	Lubricate motor and gear box.
Water separator	Weekly	Clean separator tank.
	Monthly	Check vent.
Pumps	[a]	Check for vapor and liquid leaks.
Tanks	[a]	Check for vapor and liquid leaks.
Control Device		
External refrigerated condenser	Daily	Clean any lint filters in air stream.
	Weekly	Measure temperature on exhaust for dry-to-dry machines/transfer dryer reclaimer. Measure temperature on inlet and exhaust for transfer washer.
	Weekly	Check seals, gaskets, and diverter valve for leaks.
	Monthly	Check refrigerant coils for lint build-up.
	Annually	Clean refrigerant coils.
Carbon adsorber	Daily or before saturation	Desorb.
	Weekly	Measure concentration of PCE in exhaust air stream or in machine drum, clean all lint filters, and check gaskets and ductwork.

Source: USEPA, 1994b.
[a] Maintain according to manufacturer or media supplier's specifications or recommendations.

resealed with a leak proof plug or tape. New ductwork or a manual damper can also be added for the testing. Operators should place and seal the plastic bag over the test hole during the beginning portion of the drying cycle. At that point, the vent to the control device should not be in use, but should be shut off with the exhaust damper. Operators should check to see if the plastic bag (placed over the exhaust outlet vent or test hole) inflates. If it inflates, then there is a leak and the exhaust damper will need to be repaired. It is also common for these dampers to stick in a position that does not allow them to close all the way, and thus they leak. As a result, it is very important to check the operation of the damper and its closed position very closely to ensure that the damper swings freely and closes completely when not in use. Dampers are also known to wear and will need parts repaired so that they will seal properly again.

Transfer Washer/Extractor Cylinder

Potential emissions from the washer cylinder result from leaking door gaskets. Operators should detect and repair liquid PCE leaks from door seatings and gaskets during a weekly inspection program. Operators should check for these leaks in the same manner as discussed above for leaks from the dry-to-dry machine cylinder.

Transfer Dryer (Reclaimer)

As with the washer cylinder, one source of potential PCE emissions from a dryer, or reclaimer, is through the door. Operators should check for leaking door gaskets in the same manner as discussed above for leaks from the dry-to-dry machine cylinder. Operators should not open the door before the end of the drying cycle. When the machine door is open, operators should vent the dryer air to a carbon bed. If the carbon bed is small (approximately 1- to 2-pound carbon capacity), the carbon should be changed or desorbed daily to ensure its effectiveness (NIOSH, 1997). Another main source of potential PCE emissions from dryers is through intake and exhaust dampers on exhaust systems. The machine damper gaskets should be checked monthly to ensure proper operation. It is quite common for these dampers to stick in a partially open position. As a result, it is very important to check the operation of the damper and its closed position very closely to ensure that the damper swings freely and closes completely when not in use.

Heating and Condensing Coils

Operators should check heating and condensing coils of dryers for lint build-up every month and thoroughly clean them on an annual basis. Operators should place special emphasis on the fins surrounding the heating and condensing coils. Only heating and condensing coils on older tilt back dryers for transfer systems need daily cleaning.

As mentioned above, operators should clean the coils annually at a minimum. However, if the coils are covered with lint that is difficult to remove when cleaned annually, operators should clean the coils on a semi-annual basis. Heating coils can be cleaned by blowing compressed air or steam over the coils. Condensing coils can be cleaned by brushing the coils with a stiff brush to loosen lint, then picking up the residue with an industrial vacuum.

Button Trap

The button trap lid and strainer need regular servicing. Operators should open button traps only long enough for cleaning. Operators should clean the strainer daily and check the lid for a vapor leak proof seal during the weekly leak inspection program. Operators should replace the door gasket on the button trap when needed. Operators should ensure that the lid is seated properly to prevent vapor loss and allow for proper operation of the pump (IFI, 1994).

Fans

Operators need to inspect and lubricate fans annually to ensure that they are functioning properly. According to the International Fabricare Institute (IFI, 1994), to properly control emissions the local fans for PCE drycleaning machines should be capable of maintaining a 300 to 500 cubic feet per minute air velocity.

Lint Trap

The lint trap located in the air flow system usually contains a removable lint bag or filter. Operators should clean this bag or filter daily and wash or dryclean it weekly. Operators should open lint baskets only long enough for cleaning. Operators should never run a dry-to-dry machine or dryer without a lint bag or filter and should use a second lint bag or filter while the first is being cleaned. Once a day, operators should check the ductwork in front of and behind the lint bag or filter for lint build-up. Also, operators should also make a daily check for lint build-up on machines with heat sensor probes located under or behind the lint bag or filter.

Maintenance and Operation of Auxiliary Drycleaning Equipment

In addition to the components of drycleaning machine systems, all drycleaning facilities use auxiliary equipment in the drycleaning process. This equipment is also covered by the NESHAP and includes filters, distillation units, muck cookers, and water separators. Spotting and pressing activities are not covered under the NESHAP or the CTSA; therefore, the equipment used for these activities is not discussed. Exhibit 9-1 provides a summary of recommended maintenance practices for drycleaning machine auxiliary equipment when manufacturers' information is not available. These recommendations should never supersede available manufacturers' information. The remainder of this section discusses those practices in more detail. Exhibit 8-3, "Summary of PCE NESHAP Compliance Requirements for Drycleaners," identifies the items required by the NESHAP. Section 8.1.1 summarizes the NESHAP and references other USEPA documents that contain details for complying with NESHAP requirements.

Filters

Filters are used to remove suspended particles and dyes from PCE. Several types of filters are currently used at drycleaning facilities, including spin disk (powder and powderless), constant pressure powder, regenerative powder, and cartridge filter systems. Most drycleaning facilities currently use some type of cartridge or disk filter system. Proper maintenance includes solvent recovery from filter media and muck.

Spin Disk Filters

Using spin disk filters instead of cartridge filters may lower PCE releases and increase solvent mileage (CEPA, 1993). Spin disk filters allow the operator to backwash filtered material directly into the still, which results in lower worker exposure to PCE vapors than changing cartridge filters. Spin disk filters are manufactured either to use filter powder or to be powderless. A motor drives a shaft, which spins the disks. The spin disk filters often contain 36 double-walled disks with 15-inch diameters. The disks are made of a polyester fine-mesh material and are mounted on a center support. Solvent enters the filter housing through the center mounting and flows through both walls of the disks and out through perforations on the shaft.

Soils and filter powder (if used) collect on the disks, which are stationary during filtration. Spin disk filters have a pressure gauge to measure the pressure drop across the filter. Once the pressure reaches 22 pounds per square inch (psi), the filter needs to be regenerated (NIOSH, 1997). Regeneration of the filter involves spinning the disks to wash off the soil and powder (CEPA, 1993). A drain valve opens, and the solvent, soil, and sludge flow into the still. The operator then precoats the filter with powder (if used) after each regeneration of the filter. To ensure proper performance of the PCE solvent, a powderless spin filter system may require finishing or polishing to catch and trap residual dyes.

Constant Pressure Filters

Constant pressure filters are only used in powder filtration systems. The pump must run continually to keep the powder adhered to the filter. The type of constant pressure filters presently in use uses a rigid tube. Rigid tube filters need at least 4.5 pounds of powder per 1,000 gallons per hour rated flow, or 30 square feet of filtering area, for a good precoat.

The diatomite filter powder is lightweight, organic, and composed of fossil shells. The powder forms clusters, which remain porous and allow PCE to flow through while trapping soil particles. Operators should clean off the powder built up on the tube and reapply fresh powder to the tube when the PCE flow rate decreases to 1 gallon per minute for each pound of rated load capacity that enters the wheel. The rate of build-up will vary depending on the amount of clothing cleaned, the size of the filter, and the size of the pump.

Excessive filter pressure is a common problem. The causes of excessive pressure include the accumulation of muck in the filter to a point above the manifold, which reduces the filtering area; PCE in poor condition; and nonvolatile residue, which causes slime to deposit on the filter plate if the filter is drained and not refilled. Damp filter powder and improper or insufficient precoating can also cause excessive pressure.

Operators should store all powder in a dry place to keep it from absorbing moisture. Operators should determine the correct amount of filtering powder for the filter according to the filtering area. For example, operators should use 1.5 pounds of powder per 10 square feet of filtering area for precoat and should use at least 0.5 pound per 100 pounds of clothes to maintain the filter coating. Some common causes for loss of precoat are back pressure, air in the filters, and obstructions or air leaks in the inlet line to the pump that result in uneven settling of the filter powder. Slipping pump belts or badly worn tubes could also cause a loss of precoat.

Regenerative Filters

Regenerative filters are one of the most widely used powder filters. They consist of flexible tubes that are constructed of braided metal wire, metal helical springs, or braided knit fibers. Unlike constant pressure filters, regenerative filters do not require body feed, since the precoat is bumped off after each load and is reapplied to the tube before the next load. Since no body feed is needed, operators should use 2.5 pounds of powder per 10 square feet of area to precoat regenerative filters.

The chief advantage of regenerative filters is that they do not require as much filter area as constant pressure filters. A 100-pound washer using a regenerative filter requires only 60 square feet, compared to 150 square feet for a constant pressure filter.

The braided wire tubes in regenerative filters can become crimped during the bumping operation, leaving holes in the tubes that result in leakage. Damaged tubes also allow powder and carbon to pass through the filter and muddy the PCE. Operators should correct this by repairing or replacing damaged tubes. If carbon or powder appears in the load, or the filter is not working well, operators should inspect the filter for holes and replace it if necessary.

Tubes can also become clogged. There must not be any interruption of PCE flow after precoating and while PCE is flowing into the washer. Operators should ensure that the tubes are seated properly. Backwashing may eliminate the clogging. If this is not successful, operators should remove the tubes and clean them with trisodium phosphate.

Cartridge Filters

Cartridge filters require less maintenance than regenerative or constant pressure filters because neither precoating nor body feed is necessary. The filters come in a range of sizes and use various filtering media. Because cartridges are changed routinely, manufacturers' information for cartridges is always readily available and should always be used. Operators should determine and maintain the ideal amount of clothing cleaned for each filter cartridge before stripping. To dispose of the carbon filters, operators should drain used filters for 24 hours and should steam strip drained filters at a proper steam pressure in a still, if available. There are two types of commonly used cartridges:

- *Standard Cartridges.* Standard cartridges are 7¾ inches in diameter and 14¼ inches high and use various filtering media. Carbon-core cartridges remove both insoluble soil and color from PCE. They have a normal life span of approximately 1,000 pounds per cartridge, depending on the type of work being processed and the amount of soil, moisture, and lint it contains. All-carbon cartridges primarily remove color.

- *Adsorptive Cartridges.* Adsorptive cartridges are 13½ inches in diameter and 18 inches high and contain more activated clay and carbon than standard cartridges. Half-sized cartridges, or "splits," which are 9 inches high, are also available and are easier to handle. Adsorptive cartridges are designed to remove insoluble soil and non-volatile residue along with the color. Most full-sized adsorptive cartridges are built to process 2,000 pounds before being replaced. Half-sized cartridges are made to process 1,000 pounds before being replaced. Operators should not exceed the poundage recommendations on the cartridges.

Operators should determine when to change cartridges either by the number of pounds cleaned or by a measurement pressure increase according to the manufacturers' instructions. Operators should change cartridges at a specific pressure, or at a pressure increase over the original, according to instructions and should never let the pressure exceed 40 psi. The ability to remove nonvolatile residue may be exhausted before a pressure rise indicates that the cartridge's capacity for insoluble soil has been reached. Exceeding this pressure may force soil through the filter and rupture it. If PCE starts to become too dark or streaks and swales appear, operators should change cartridges or increase the distillation rate.

Operators should ensure that gaskets or felt washers used between the cartridges are seated properly. Gaskets that are damaged or used too long can allow soil to leak out. Some all-carbon cartridges take a different size gasket than other cartridges made by the same manufacturer. Operators should read the manufacturers' instructions carefully and replace gaskets frequently.

Excess moisture or poorly dispersed moisture in the filter will cause a rapid increase in pressure. The same result may occur when some water repellents or fabric finishes are removed from fabric by the PCE and carried over into the filter.

Operators should inspect new cartridges for physical damage before installing them. Also, a new set of cartridges will often leak insoluble soil and carbon until several loads have been cleaned. Operators should run only dark loads until this leakage stops.

Distillation Unit

The purpose of a distillation unit is to purify and recover used PCE to recycle it back into the drycleaning system. Distillation units typically consist of steam and condensation coils. Water and PCE retrieved from the distillation process are channeled to a water separator. Potential PCE loss from these units can be due to leaks in seals and gaskets, build-up of still bottoms on the heating coil, and improper water or steam temperatures.

Seals and gaskets in the distillation unit should be checked for leaks and repaired at least every 2 weeks. The steam and condensation coils for the distillation unit should be checked monthly and cleaned semi-annually to avoid lint build-up. They may be cleaned in the same way as the coils used in the drycleaning machine. Some stills do not require coil removal for cleaning.

The following practices are recommended to achieve optimum still performance and minimize PCE in the still residue:

- Operators should never exceed 75% of the still kettle capacity, or the level recommended by the manufacturer.

- Operators should set up condenser water flow countercurrent to PCE flow.

- Operators should keep the PCE return temperature at a maximum of 32°C (90°F) to minimize evaporative loss through the PCE storage tanks.

- Operators may redistill still bottoms used solvent at a rate of 6 to 8 gallons per 100 pounds of clothes cleaned (IFI, 1994).

- Operators may redistill still bottoms with more water following boil down to recover more solvent. However, this may create more hazardous wastewater and maintenance problems (USEPA, 1997).

Muck Cooker

Older drycleaning systems with tubular powder filtration systems (constant pressure and regenerative) use muck cookers to distill the residue from these systems. Maintenance procedures for muck cookers are the same as for distillation units, except that annual or more frequent lubrication of the motor and gear box is needed.

Water Separator and Water Evaporator

Water separators separate water and PCE from the PCE-water mixture that comes from various condensates, including carbon desorption, distillation, machine condenser, and pressing. To function properly, water separators must be vented to the atmosphere. The vent can become clogged and should be checked each month. The maintenance schedule for water separators should also include vapor and liquid leak detection procedures. In addition, operators should clean the separator tank weekly. It should be noted that separator water usually contains minor amounts of PCE. Operators should treat separator water as a hazardous waste and should not pour it down a drain or flush it down a toilet.

A proper way to control PCE from separator water is through double-activated carbon treatment of separator water and evaporation (provided the separator water does not contain a layer of separated PCE). Operators should send the spent carbon cartridges and other hazardous wastes to a USEPA-licensed hazardous waste hauler. Vapor from the evaporator contains PCE and should be vented outside the facility. Venting this vapor inside the facility may increase PCE concentrations in the facility and may increase workers' exposure to PCE.

Maintenance and Operation of Emission Control Devices

USEPA's NESHAP for PCE drycleaning was intended to reduce emissions primarily by introducing requirements for emission control devices. Under the NESHAP, drycleaning machines installed before December 9, 1991, are considered "existing" machines, while machines installed on or after December 9, 1991, are considered "new" machines (USEPA, 1994a). All "new" drycleaning machines must be equipped with at least a refrigerated condenser used as a PCE vapor recovery system.

"Large"[1] drycleaners with "existing" drycleaning machines must be equipped with a refrigerated condenser (or a carbon adsorber if it was in place before September 22, 1993). "Small"[2] drycleaners do not need to install PCE vapor recovery systems on "existing" machines. In addition, existing major source drycleaning facilities must keep their transfer machine systems inside a room enclosure, and new major source drycleaning facilities must install both a refrigerated condenser and a secondary carbon adsorber.

Exhibit 9-1 provides a summary of recommended maintenance practices for refrigerated condensers and carbon adsorbers. These recommendations should never supersede available manufacturers' information. The remainder of this section discusses those practices in more detail.

Refrigerated Condensers

Drycleaning operators should route the refrigerated condenser's one-pass outlet ducts to exhaust outside the plant. The ducting is recommended in the rare configurations where the refrigerated condenser exhausts to the atmosphere. The NESHAP requires temperature monitoring and checking of all gaskets and seals during a weekly leak detection and repair program. Operators should clean all lint filters in the ductwork associated with refrigerated condensers on a daily basis.

Carbon Adsorbers

Operators should route carbon adsorber (CA) one-pass outlet ducts to exhaust outside the plant. The exhaust stack should be monitored during the exhaust process with a detector tube, an ionization detector, or an equivalent sensor (NIOSH, 1997). Integral CAs in fourth and fifth generation machines (see Chapter 2 for equipment details) are not included since these CAs do not exhaust to the atmosphere. It is also recommended that operators determine the maximum quantity of PCE that the CA can hold. The CA must be desorbed (i.e., steam stripped) daily, unless the daily return of PCE from the CA is less than 50% of that capacity. One way to determine the maximum capacity a CA can hold is to check the CA exhaust with a colorimetric detector tube. Once the exhaust reads over 100 ppm (parts per million) of PCE, the CA is considered saturated. Operators should then completely desorb the saturated CA by steam desorption for 1 hour. The amount of PCE returned from this desorption will be the maximum quantity of PCE that the CA can hold.

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[1]"Large" drycleaners are defined as facilities (1) with transfer machines only and that purchase 200 or more gallons of PCE per year; (2) with dry-to-dry machines only and that purchase 140 or more gallons of PCE per year; or (3) with a combination of dry-to-dry and transfer machines and that purchase 140 or more gallons of PCE per year.

[2]"Small" drycleaners are defined as facilities (1) with transfer machines only and that purchase less than 200 gallons of PCE per year; (2) with dry-to-dry machines only and that purchase less than 140 gallons of PCE per year; or (3) with a combination of dry-to-dry and transfer machines and that purchase less than 140 gallons of PCE per year.

Operator maintenance is crucial with carbon adsorption. The NESHAP recommends the following operating and maintenance practices:

- Operators should clean the lint screen regularly.

- Operators should check for leaks in the damper that restricts steam from entering the adsorber.

- Operators should determine and maintain the maximum or ideal ratio of clothes cleaned per activated carbon used (USEPA, 1997).

- Operators should determine and maintain ideal stream pressure passed through the bed to strip solvents from the carbon beds (USEPA, 1997).

- Operators should restrict desorption to a maximum of 60 minutes, whether or not PCE is still returning. It is extremely important to dry out the adsorber for at least 15 minutes after desorbing.

- If, after an undetermined period, the carbon bed becomes contaminated, then operators should try an extended, all day steam stripping at the highest possible steam pressure. If that does not burn off the contamination, the carbon bed may have to be replaced.

- Operators should determine how often to desorb and maintain that schedule. An adsorber's capacity is determined by the pounds of carbon it contains. Typical adsorber capacities are 2 gallons, 4 gallons, or 6 gallons.

- To establish a desorption schedule, operators should begin by desorbing every day. If the capacity is 4 gallons and every day produces less than 2 gallons but at least 0.5 gallon, operators should strip every second day. If the stripout produces more than 2 gallons, operators should strip every day. If the stripout produces 4 gallons every day, operators must strip twice daily, or preferably, determine why so much PCE is getting to the adsorber and remedy the problem. If the stripout produces no more than 1 gallon daily, operators should strip the carbon adsorber every third day.

In addition to the monitoring requirements of the NESHAP, operators should clean all lint filters and screens associated with carbon adsorbers on a weekly basis. Operators should include all gaskets and ductwork associated with the carbon adsorber in a weekly detection and repair program.

Operators should always maintain the proper air filter type specified by the manufacturer. Some older "lint filters" (e.g., furnace filters) may be improper. Improper filters can allow fine particles to slowly clog the pores of the activated carbon. This clogging reduces the ability of the carbon to adsorb PCE.

A CA's maximum holding capacity can diminish substantially over time depending on how heavily the carbon is used. Operators can use a cumulative flow meter to monitor the solvent recovery process. It is recommended that operators consider replacing or reactivating the activated carbon every 5 years, or more or less frequently depending on how heavily the adsorber is used.

Facility Design and General Operating Procedures

Additional practices to improve environmental performance involve the design of exhaust and ventilation systems and proper operating procedures. This section discusses those issues in more detail. Recommendations in this section should never supersede available manufacturers' information for the systems discussed.

Exhaust Systems

Proper design and maintenance of exhaust systems is essential for controlling emissions. Local exhaust systems consist of an exhaust fan, ductwork, and a hood. Local exhaust systems are designed to collect contaminants at the source to prevent their escape into the work environment, thus reducing PCE exposure (NIOSH, 1997). Operators should use elevated hoods between the washer and dryer for transfer operations rather than less effective floor ducts to collect vapors into local exhaust systems. Operators should avoid abrupt changes in duct size in local exhaust systems. Operators can also install permanent pressure gauges on local exhaust systems to allow identification of system performance changes. Operators should practice regular maintenance procedures and promptly repair holes in air and exhaust ducts upon detection. Operators should use exhaust ventilation through doors of washers and dryers.

The National Fire Protection Association (NFPA) guidelines recommend that drycleaning machines have an integral exhaust system and a door face velocity of at least 100 feet per minute (NIOSH, 1997). This face velocity provides a draft of clean air over the items removed from the machine, thus reducing solvent vapors escaping into the shop. Also, the Michigan Department of Public Health Rules state that the blower must be ducted to a point 5 feet above the roof. This prevents vapors from re-entering the work environment. Another option is to place a ventilation hood outside the machine door and maintain an airflow capacity in cubic feet per minute, not less than 100 times the door opening area in square feet (NIOSH, 1997).

Ventilation Systems

Proper design and maintenance of ventilation systems is also essential for controlling emissions. Local ventilation involves removing the contaminant at or near the source to prevent emissions from reaching the breathing zone or diffusing through the plants (NIOSH, 1997). Subsequently, general ventilation involves diluting the concentration of the contaminant before it reaches the worker's breathing zone. Drycleaning systems should pull air from other areas into the drycleaning area to avoid solvent dispersion into peripheral plant areas (i.e., operators should keep the drycleaning and pressing rooms under negative pressure). Operators should design ventilation systems in temperate climate areas for winter conditions when natural ventilation is at a minimum. Also, operators should adequately ventilate areas where garments are hung after removal from the dryer. According to NFPA codes and Michigan Department of Public Health Rules, there should be an air change in the workroom every 5 minutes to decrease background PCE concentrations (NIOSH, 1997).

Liquid Leakage and Vapor Control

To find liquid leakage, operators should look for the brown residue of PCE-soluble nonvolatile compounds on the underside of fittings. This can be a sign of leakage in pipe fittings, welds, elastomers, and plastic hose connections. Loose pipe connections are generally caused by wear, normal expansion and contraction created by temperature, and vibration of equipment. Operators should check connections, unions, and couplings as soon as they start to leak. When required, operators should replace the packing on the valves.

PCE loss from pipe fittings can be considerable. For example, PCE dripping at the rate of one drop per second means that a gallon of PCE is lost in an 8-hour work day. Routine checkups with a portable halogenated hydrocarbon leak detector around the pumps, seals, flanges, door openings, and other components of the machine can detect vapor losses before they become leaks (CEPA, 1993).

The proper storage and use of chemicals can also prevent liquid leaks. Operators should properly label all chemicals and should not store chemicals in extreme heat or cold, which may diminish the chemicals' shelf-life or make them unusable (USEPA, 1997). New solvent, saturated lint from lint baskets, dirty filters or filter powder, and recovered solvent from condensers, adsorbers, and water separators should all be collected and stored in closed containers (NIOSH, 1997). Operators should provide secondary containment around storage areas and should keep dip tanks for water repellent covered, even during the drainage of clothing (USEPA, 1997). Operators should drain filter cartridges in a closed container or consider drying filters in housings vented to carbon adsorbers. Operators should not allow hazardous materials to mix with non-hazardous materials, as this will result in all of the waste requiring hazardous waste treatment. Finally, it is important to inspect all chemical and waste storage containers for leaks.

Transfer Operations

To prevent PCE releases and exposure during transfer operations, the washer and dryer should be near each other in PCE systems (NIOSH, 1997). HC transfer machines, however, should be separated to reduce the fire hazard. Operators should transfer clothing from washer to dryer quickly after drainage and close machine doors immediately after loading and unloading. Enclosed, automated transfer from washer to dryer may be an additional prevention measure.

Exhibit 8-3, "Summary of PCE NESHAP Compliance Requirements for Drycleaners," includes requirements for certain transfer operations. In some cases, operators may implement these requirements using room enclosures. Room enclosures without adequate ventilation may contain high PCE concentrations. Therefore, operators must ensure that PCE concentrations in room enclosures do not exceed regulatory limits such as the OSHA PELs. Operators should design room enclosures to avoid increasing their workers' exposures to PCE.

Cooling Water or Drying Temperature

If the temperature of the cooling water or refrigerant is not kept low enough, the condenser coils cannot cool the air stream enough, and less PCE condenses out of the stream. When the air is recycled to the dryer, it cannot pick up as much PCE, and drying takes longer. One indication of this problem is if clothes have a PCE odor after the end of the typical drying cycle. In summer months in warmer climates, this can be a problem at drycleaning facilities using water-cooled condenser coils and water cooling towers. The water-cooled condenser temperature should be no higher than 90°F (NIOSH, 1997). Some potential solutions are to increase drying time, use a water chiller, or use a city water supply. The exhaust air stream from a refrigerated condenser must not be above 45°F (USEPA, 1994a).

Drying temperature is important for the same reasons as proper cooling temperature. If the temperature is not hot enough, clothes will not be dry when the cycle is completed. The operator should maintain adequate steam pressure to keep the drying temperature between 135°F and 145°F for a regular cycle and about 120°F for a fragile load (IFI, 1994; NIOSH, 1997).

Drying Time

The drying cycle should be long enough to ensure that garments are completely dry when they are finished. The operator should not open the machine door until the drying cycle is complete. In addition, the proper cycle length may vary according to the amount of air flow through the machine. To ensure the maximum amount of air flow in the machine, operators should keep the steam and condenser coils and lint bags clean.

Loading of Machine

To ensure that clothes are completely dry and that machines recover the maximum amount of PCE, it is recommended that machines be under-loaded by at least 5 pounds, but not by more than 25% of the machine’s capacity. Otherwise, the normal PCE losses that occur when running the machine will outweigh the PCE savings gained by slight under-loading.

When feasible, operators should clean clothes of similar types together. If mixtures of fabric types are cleaned, some clothes removed from the machine may not be dry or may be damaged by excess drying (USEPA, 1997).

Handling of Other Wastes

Waste reduction applies to all wastes generated, not just hazardous waste. Operators should try to replace disposable items with reusable ones (USEPA, 1997). For example, operators should ask suppliers to provide solvents in returnable containers. Operators should recycle materials such as plastics, glass, cardboard, and paper and should encourage customers to use reusable garment bags or to return unused hangers (Department of Natural Resources and Environmental Control, 1998). Operators should maintain a consistent waste reduction policy and should try to identify other possibilities. A successful waste reduction program continually searches for additional ways to eliminate wastes.

9.1.2 Impact of Facility Conditions and Remedial Actions on PCE Concentrations in Co-located Residences

There is empirical evidence to demonstrate that remedial actions and proper maintenance can lower PCE emissions in co-located residences. However, results of such studies vary because successful remediation must encompass all PCE transmission pathways.

Overall facility conditions affect PCE concentrations in co-located residences in many ways (BAAQMD, 1993; MHS, 1993; NYSDOH, 1993a, 1994). It is important for drycleaning owners and operators to understand the prospective benefits of proper maintenance procedures, remedial actions, and state-of-the-art equipment. USEPA has reviewed the available information and has drawn the following conclusions:

- Buying a state-of-the-art machine will not eliminate PCE concentrations in co-located residences, but it can reduce them, perhaps substantially (depending upon the condition of the old machine).

- Vapor barriers and room enclosures are marginally effective in reducing PCE concentrations in co-located residences, and their effectiveness increases when they enclose both the drycleaning and pressing areas.

- Proper machine maintenance is very important. For example, saturated carbon adsorbers can elevate PCE concentrations.

- Building condition is also important. Cracks and holes in the ceiling facilitate PCE transmission.

- Venting above the roof at a high velocity may substantially alleviate PCE concentrations.

- Alleviation of the problem is not guaranteed even after substantial remedial efforts, particularly if pathways of PCE transmission remain intact.

- Remedial efforts must address the whole problem if they are to succeed. For example, substantive machine modifications and the construction of vapor barriers will not compensate for holes in the ceiling.

These conclusions are based on a review of several studies conducted in the U.S. and abroad. The most informative of these studies was an in-depth look at remediation for two drycleaners in New York City (NYSDOH, 1994). For one of these drycleaners (Facility 21), three sets of remedial actions were inadequate to alleviate concentrations of PCE in a co-located residence. These remedial actions included building a room enclosure and installing a vapor barrier. Indoor air sampling in a second floor apartment showed a PCE concentration of 12.7 mg/m^3 (NYSDOH, 1994).

The above-mentioned remediations to Facility 21 did not include repairing large holes in the ceiling above the pressing area. These holes provided an ideal route of PCE transmission from the facility on the ground floor to the apartments on the second floor (NYSDOH, 1994). This highlights the importance of addressing all PCE transmission pathways before undertaking remedial efforts. To be successful, remediations in co-located facilities must include operator training, improved machine maintenance, repairs to the building, and blockage of other obvious routes of PCE transmission such as venting to a courtyard. Again, successful remediation requires more than upgrading machines and building vapor barriers.

For the other drycleaner (Facility 41), a facility with apartments next door, remediation resulted in improvements but did not eliminate PCE concentrations. As part of the remediation efforts, the owner of the drycleaner facility built a room enclosure around the machines, installed a vapor barrier, improved ventilation, tried to reduce the available pathways of PCE transmission through the building, and improved the PCE reclamation process. However, PCE concentrations ranged from ambient levels (0.026 mg/m^3) to nearly 5 mg/m^3 after these remedial efforts (NYSDOH, 1994).

New York State officials have performed and supervised remedial efforts on a number of other drycleaners, mainly to reduce PCE concentrations in the facility itself. The results show that reductions in PCE concentrations inside the facility do not necessarily lead to the elimination of PCE concentrations in the co-located residence (NYSDOH, 1993b).

In San Francisco, PCE concentrations were measured above facilities with state-of-the-art equipment and controls. PCE concentrations measured by the Bay Area Air Quality Management District (BAAQMD) above four non-vented dry-to-dry machines with refrigerated condensers ranged from 0.002 to 0.67 mg/m^3. These concentrations are lower than most of the reported samples taken in New York (BAAQMD, 1993). The BAAQMD’s recommendation is that a “combination of state-of-the-art equipment, good diffusion proofing (barriers/taping), and high ventilation rate (10,000 cubic feet per minute) may be the optimal solution for preventing exposure of PCE to people residing above drycleaning facilities” (BAAQMD, 1993).

The effects of remediation have also been examined in Amsterdam, the Netherlands, as part of a study of PCE concentrations in co-located residences. Here again, the results indicate that remedial actions do not necessarily remove the concern. PCE concentrations were relatively high after remedial actions took place (MHS, 1993).

Machine type also affects PCE concentrations in co-located residences. A study of PCE concentrations above three transfer machines, two well-functioning dry-to-dry machines, and one dry-to-dry machine in poor condition was performed in Capital District, New York. The results showed that PCE concentrations above the transfer machines were higher than concentrations above the two well-functioning dry-to-dry machines. The maximum PCE concentration at the pressing station was found to correlate well with the measured concentrations in co-located residences. However, no correlation was found with the residential concentrations and the type of ceiling and location of exhaust vents (NYSDOH, 1993a).

Other New York State data collected in response to residential complaints show that PCE concentrations above non-vented dry-to-dry machines are significantly lower than concentrations above vented dry-to-dry and transfer machines.

9.2 MACHINE WETCLEANING FACILITIES

Information on best management practices and environmental and exposure control options for this technology is very limited. Several of the following may be considered but should not supersede available manufacturers' information:

- Automated addition of water and chemicals to washing machines, particularly decreasing the amount of human error due to spillage or addition of excessive detergent amounts.

- Good housekeeping practices, such as keeping detergent storage containers tightly closed to reduce chance of spillage.

- Recycling/recovery of rinse water/steam condensate.

9.3 TRADE ASSOCIATION CONTACTS FOR FURTHER INFORMATION

This section provides a summary of the major clothes cleaning trade and research associations, their contact numbers, and their initiatives and publications involving environmental improvement practices. This listing does not constitute endorsement of these institutions, their initiatives, and publications, nor is the listing intended to be a complete listing of sources that may have beneficial information. Rather, this list is intended as a source of some information that may prove useful to drycleaners and others interested in drycleaning issues.

Neighborhood Cleaners Association International (NCAI)
252 West 29th Street
New York, NY 10001-5201
Tel: (212) 967-3002

NCAI initiatives and publications include a training manual and a publication entitled "Keep It Clean: Guidelines To Reduce or Eliminate PCE Releases to Air, Soil, and Water." These offer useful maintenance and operation guidelines. NCAI also offers a self-test on the Internet that covers such topics as hazardous waste laws; laws on discharges to ground (soil), air, and water; Occupational Safety and Health laws; general requirements; tanks; and the federal NESHAP.

Federation of Korean Drycleaners Association (FKDA)
25606 Alicia Parkway
Lagona Hills, CA 92653
Tel: (714) 770-8613

FKDA provides educational opportunities through newsletters as well as educational seminars on subjects such as pollution prevention and other critical issues. State FKDA chapters may provide additional resources to their members.

International Fabricare Institute (IFI)
12251 Tech Road
Silver Spring, MD 20904
Tel: (301) 622-1900

IFI initiatives and publications include a training manual that describes compliance issues, pollution prevention practices, proper waste handling procedures, waste reduction methods, and occupational safety methods. IFI also implements the Certified Environmental Drycleaner (CED) program, which promotes the environmentally improved operation of drycleaning establishments. To become a CED, a drycleaner must pass a standard examination that tests drycleaners on various environmental topics, including environmental regulations, proper waste handling, occupational safety and health, safe operation of drycleaning equipment, and other federal regulatory requirements. IFI also offers a self-study drycleaning course that focuses on drycleaning and the environment. This course includes USEPA regulations, OSHA regulations, recent federal regulations, state regulations, and operating practices and procedures. IFI also published an article that focuses on maintenance guidelines and offers a checklist for minimizing pollution:

International Fabricare Institute. 1993. Pollution prevention in the drycleaning industry. Industry Focus. No. 5. November.

Hohenstein Institutes (Forschungsinstitut Hohenstein)
Boenningheim, Germany
Tel: 011-49-7143-2710
Fax: 011-49-7143-2717

The Hohenstein Institutes are an independent, internationally recognized research and service center. The Hohenstein Institutes have published research reports that focus on fugitive emission control technologies, analytical measurements, and the effectiveness of diffusional barriers in 114 German drycleaning plants. Relevant reports include:

1. Hohenstein Institutes. 1991. The feasibility of lowering solvent vapor load in the vicinity of drycleaning machines. Research sponsored by the German Environmental Protection Agency. September.

2. Hohenstein Institutes. 1994. Reduction of solvent vapor concentration in the vicinity of drycleaning plants. Research sponsored by the six German State Agencies. November.

Additional information can be retrieved from the Hohenstein Institutes' Web site at <http://www.hohenstein.de/englisch/kurzcon1.htm>.

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